TOTAL MAXIMUM DAILY LOAD (TMDL)

For
Dissolved Oxygen and Nutrients
In
North St. Lucie River
(WBID 3194)

St Lucie Estuary
(WBID 3194B)

C-24 Canal Watershed
(WBID 3197)

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AWT	Advanced Waste Treatment
BMP	Best Management Practices
BPJ	Best Professional Judgment
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
F.A.C.	Florida Administrative Code
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agriculture Statistics Service
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSTD	Onsite Sewer Treatment and Disposal Systems
PLRG	Pollutant Load Reduction Goal
Rf3	Reach File 3
RM	River Mile
STORET	STORage RETrieval database
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WBID	Water Body Identification
WLA	Waste Load Allocation
WMP	Water Management Plan
WWTF	Wastewater Treatment Facility

SUMMARY SHEET
Total Maximum Daily Load (TMDL)

1. **303(d) Listed Waterbody Information**
   State: Florida
   Major River Basin: St. Lucie River Basin

Impaired Waterbodies for TMDLs (1998 303(d) List):

WBID	Segment Name and Type	River Basin	County	Constituent(s)
3194	North St. Lucie	St. Lucie	St. Lucie	DO and Nutrients
3194B	St. Lucie	St. Lucie	St. Lucie	Nutrients
3197	C-24	St. Lucie	St. Lucie	DO, BOD and Nutrients

2. **TMDL Endpoints (i.e., Targets) for Class III Waters (fresh and marine):**

The State of Florida has narrative criteria for nutrients stating that in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna. A Chlorophyll a target of 15 ug/l, as a maximum monthly value, was used as the water quality endpoint. This 15 ug/l Chlorophyll a target is used by Florida Department of Environmental Protection, U.S. Army Corps of Engineers and the South Florida Water Management District as an indicator to identify algal blooms and using the 15 ug/l as a maximum monthly value should prevent the algal blooms and prevent the imbalance in natural populations of aquatic flora or fauna. Biochemical Oxygen Demand (BOD) was also addressed, as it is a pollutant that impacts dissolved oxygen (DO). BOD shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each class and, in no case, shall it be great enough to produce nuisance conditions.

TMDLs for nutrients in WBIDs 3194B and 3194 and low DO in WBID 3194 were addressed by analyzing the effects of total nitrogen (TN), and total phosphorus (TP) loads on Chlorophyll a concentrations using a site specific Chlorophyll a nutrient spreadsheet model. The BOD loadings were developed using the Nonpoint Source Spreadsheet model.

The target for DO is based on the State of Florida's water quality criteria for DO, which requires that in no case should the concentration of dissolved oxygen be less than 5 mg/L for freshwater (C-24) and 4 mg/l for marine waters (St Lucie and North St Lucie).

3. **Nutrient and BOD Allocation:**

A reduction in TN and TP from all sources (nonpoint and point sources including MS4 and WTF discharges) for St Lucie River Basin including all major watersheds and Lake Okeechobee's discharge to C- 44 canal, is required to meet the Chlorophyll a target of 15 ug/l as a maximum monthly value. A 46% reduction in BOD for WBID C-24 is also needed to meet the DO targets for WBID 3197.

Stream Name / WBID	Parameter	TMDL
North St Lucie and St Lucie Estuary (3194B and 3194)	TN	3,868,000 #/year or 10,590 #/day
North St Lucie and St Lucie Estuary (3194B and 3194)	TP	245,000 #/year or 670 #/day
C-24 Canal (3197)	TN	579,620 #/year or 1588 #/day
C-24 Canal (3197)	TP	48,180 #/year or 132 #/day

.

Stream Name / WBID	Parameter	WLA for MS4	LA	TMDL
St Lucie (3194)	TN	26.5 % Reduction	26.5 % Reduction	26.5 % Reduction
St Lucie (3194)	TP	70 % Reduction	70 % Reduction	70 % Reduction
North St Lucie (3194B)	TN	26.5 % Reduction	26.5 % Reduction	26.5 % Reduction
North St Lucie (3194B)	TP	70 % Reduction	70 % Reduction	70 % Reduction
C-24 Canal (3197)	TN	28 % Reduction	28 % Reduction	28 % Reduction
C-24 Canal (3197)	TP	75 % Reduction	75 % Reduction	75 % Reduction
C-24 Canal (3197)	BOD	46% reduction	46% reduction	46% reduction

* Percent reductions are an averaged reduction for the TN and TP loads from all contributing watersheds and canals.

4. **Endangered Species (yes or blank): Yes**

5. **EPA Lead on TMDL (EPA or blank): EPA**

6. **TMDL Considers Point Source, Nonpoint Source, or both: Both**

7. **Major NPDES Discharges to surface waters addressed in TMDLs: None**

TOTAL MAXIMUM DAILY LOAD (TMDL) DISSOLVED OXYGEN AND NUTRIENTS IN ST. LUCIE WATER BODY IDS 3194 AND 3194B AND C-44 CANAL WATER BODY ID 3197

1. INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources (USEPA, 1991).

The State of Florida Department of Environmental Protection (FDEP) developed a statewide, watershed-based approach to water resource management. Under the watershed management approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework FDEP uses for implementing TMDLs. The state's 52 basins are divided into 5 groups. Water quality is assessed in each group on a rotating five-year cycle. The Group 2 basin is shown in Figure 1 and includes the St. Lucie and Loxahatchee River Basins. The St. Lucie and Loxahatchee Basins encompass many square miles. To provide a smaller-scale geographic basis for assessing, reporting, and documenting water quality improvement projects, the FDEP subdivided the Group 2 area into smaller areas called planning units. Planning units help organize information and management strategies around prominent subbasin characteristics and drainage features. To the extent possible, planning units were chosen to reflect subbasins that had previously been defined by the South Florida Water Management District (SFWMD). The St. Lucie and Loxahatchee Basins contain eight planning units: C-25/Basin 1, North St. Lucie, C-24, C-23, South St. Lucie, C-44, Loxahatchee, and Coastal. Water quality assessments were conducted on individual waterbody segments within planning units. Each waterbody segment is assigned a unique waterbody identification (WBID) number. Waterbody segments are the assessment units or polygons that have historically been used by the FDEP to define waterbodies in their biannual inventory and reporting of water quality to EPA under Section 305(b) of the federal Clean Water Act. The same WBIDs are also the assessment units identified in the FDEP's biannual lists of impaired waters submitted to EPA as part of their reporting under Section 303(d) of the Clean Water Act.

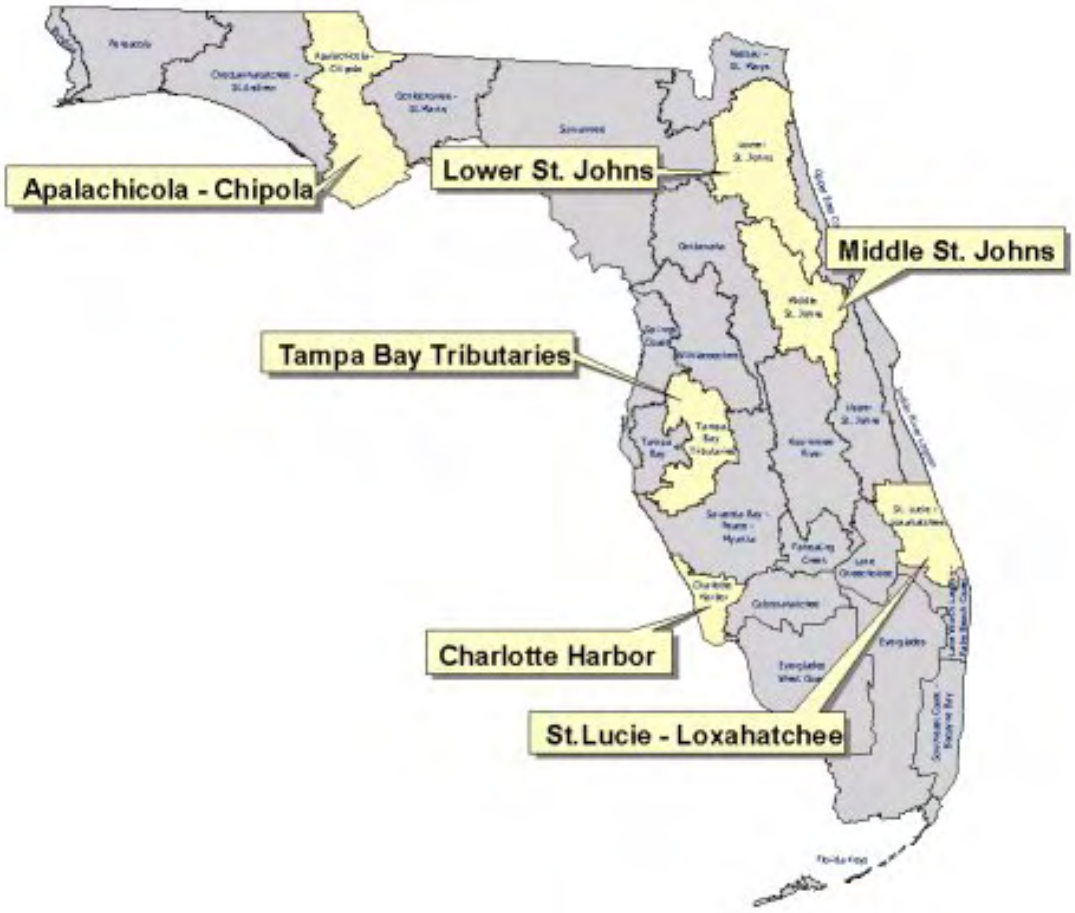

Figure 1: FDEP Group 2 River Basins

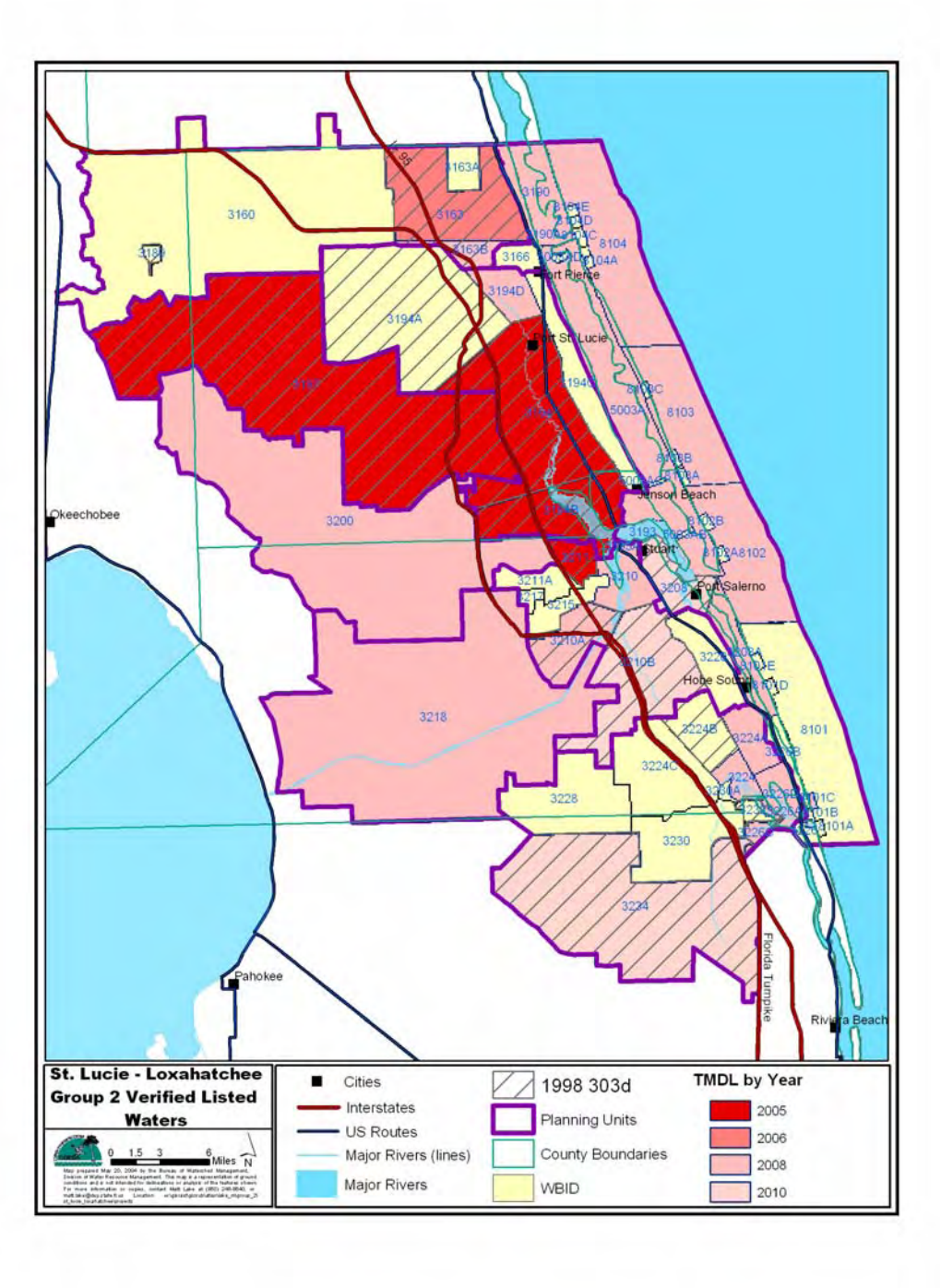

Figure 2: St. Lucie / Loxahatchee River Basin.

2. PROBLEM DEFINITION

Florida's final 1998 Section 303(d) list identified WBIDs 3194, 3194B and 3197 in the St. Lucie River Basin as not supporting water quality standards (WQS) due to dissolved oxygen and/or nutrients. After assessing all readily available water quality data, EPA is responsible for developing a dissolved oxygen and/or nutrient TMDL in the St Lucie River Basin, which contains the impaired WBIDs 3194 (North St. Lucie), 3194B (St. Lucie Estuary) and 3197(C-24 Canal). The locations of these WBIDs are shown in Figure 2. The TMDL addressed in this document are being established pursuant to EPA commitments in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998).

These WBIDs are designated as a Class III waters. The designated use of Class III waters is recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. Class III waters are further categorized based on fresh (3197) or marine waters (3194 and 3194B).

3. WATERSHED DESCRIPTION

As discussed in the introduction, FDEP manages water resources based on river basins. The river basins are organized from large groups of major river basins to smaller watersheds called planning units, and finally to small waterbody polygons called WBIDs. The St. Lucie River Basin, North St. Lucie Planning Unit, and North St. Lucie WBID are described next. The following information is from the 2003 FDEP Basin Status Report for St. Lucie and Loxahatchee. In the St. Lucie Basin, most of the land in the non-coastal areas is used for the production of citrus and beef cattle. The extensive network of canals that drains these agricultural areas transports storm-water runoff containing nutrients, sediment, bacteria, and other pollutants. These reach the natural drainage-ways (such as the North and South Forks of the St. Lucie River) and ultimately the St. Lucie Estuary and the South Indian River Lagoon. The St. Lucie Canal (C-44), the inland waterway that connects Lake Okeechobee to Florida's east coast, transports regulated releases of water from Lake Okeechobee and runoff from agricultural areas within the C-44 basin. Other major canals also transport storm-water from inland agricultural areas to the estuary. Canals C-23 and C-24 discharge water into the North Fork of the St. Lucie River and the C-25 Canal discharges to the Indian River Lagoon. These canals transport loads of nutrients and eroded sediment to the estuary and slugs of fresh water that create fluctuations in estuarine salinity levels. Urban and residential areas continue to expand in the coastal areas, with polluted urban storm-water runoff and seepage from septic tanks also contributing to the water quality problems in streams and canals. As a result, parts of the St. Lucie Estuary (SLE) appear to be impaired by nutrients, copper, and low levels of DO. Nutrient loads, salinity fluctuations, and accumulations of sediment stress the estuarine ecology. Other evidence of impairment was gathered for the SLE segments in a FDEP South East District biological survey (Graves et al., June 2002). Sediment accumulation, decline of sea-grasses and oysters, algal blooms, fish kills, and low diversity of benthic macroinvertebrates in the SLE

comprise this body of evidence.

WBID 3194 is in the North St. Lucie planning unit of the St. Lucie Basin. It extends from Ft. Pierce Inlet to the St. Lucie Inlet and westward to the C-24 Canal. Historically it has drained naturally into the St. Lucie Estuary and includes the North Fork St. Lucie River and its main tributaries, Tenmile Creek, and Fivemile Creek. The WBIDs are 48% residential as shown in Table 1 which shows the land-use and land-cover distribution. The planning unit also includes the North St. Lucie Water Control District, located in the northern part where drainage is to Tenmile Creek, C-25 Canal, and the C-24 Canal. The North St. Lucie planning unit is located in eastern St. Lucie County and includes Port St. Lucie and the western half of Ft. Pierce, the western part of Stuart, as well as Palm City, North River Shores, and Lighthouse Point. This watershed is now greatly modified by canals. The eastern terminus of the C-24 Canal is located in this North St. Lucie planning unit. Water from C-24 is released to the North Fork of the St. Lucie River via the C-23A Canal. Figure 3 is a composite map of this planning unit that shows potentially impaired waters and potential point sources of pollution.

Approximately 14 percent of this planning unit has been identified as wetland and 12 percent as upland forests. The wetland areas are located primarily in two areas, along the North Fork of the St. Lucie River and in the Savannas wetland. The Savannas State Reserve is an Outstanding Florida Water (OFW). All waters in this planning unit are designated as Class III, including canals. Straightening and channelization have significantly modified the North Fork of the St. Lucie River, a state aquatic preserve. These modifications have reduced the river system's ability to filter sediment and attenuate nutrients and have dramatically reduced the wetlands that provide habitat. Sediment transported into the North Fork has been accumulating in abnormal quantities in the river bed (Gardner, 1984). The North Fork forms the upper segment of the SLE. Adverse ecological impacts to the estuary caused by the canal discharges of nutrients, sediment, and fresh water are well documented. A water quality study on Tenmile Creek, the major tributary to the North Fork, identified significant concentrations of pesticides in the water (most notably malathion and ethion) that are apparently related to citrus farming in the Tenmile Creek Basin (Graves and Strom, June 1995). Fish kills and the documentation of degraded biological communities in Tenmile Creek may be attributable to the pesticide load. Sedimentation in Tenmile Creek and the North Fork due to canal erosion in the NSLWCD has also been documented as a concern (NSLWCD, 2000).

A significant portion of this planning unit is in agricultural land use, primarily citrus production. Individual citrus growers are participating in the BMP program to reduce pollutant loadings to storm-water. Several programs supported by the St. Lucie River Issues Team are focused on reducing irrigation volumes that directly affect the volume of polluted runoff and the magnitude of transported sediment from irrigated citrus groves. In the Citrus Irrigation Conversion project supported by NRCS, cost-share contributing growers in the North St. Lucie planning unit are converting to low-volume irrigation equipment to help reduce discharges. Currently, storm-water transported by canals C-23 and C-24 enters directly into the North Fork St. Lucie River through tidal structures. The IRL South Feasibility Study includes the northern diversion component that will result in a significant improvement to the quality and better regulation of water discharged

to the North Fork. Under this component, storm-water from the C-23 and C-24 Canals will be diverted into one of two reservoirs to be constructed in the along the eastern boundary of the C-24 and C-23 basins (C-23/24 North and South Reservoirs). Water from these reservoirs could be returned to the canals to equalize storage, to supply water, or to be diverted to the C-23/24 storm-water treatment area (STA), located in the northwestern part of this planning unit, where it would be treated. From the STA, the treated water would be routed via a bypass canal to Tenmile Creek and into the North Fork. The northern diversion component will improve the quality of water and the timing of fresh water being delivered to the North Fork and the SLE. Hydrologic models predict that it can come close to achieving pre-drainage distribution flows (quantity) to the North Fork. The Feasibility Study also includes a significant project to restore the natural hydrology of the North Fork by reconnecting river floodplains and oxbows and returning the river to a condition similar to its historic path. The North Fork Floodplain Restoration component will increase the capacity of the river to accommodate flows and improve water quality and habitat. This component is also a St. Lucie River Issues Team project. The North Fork Floodplain Restoration project is already underway. It was one of the numerous water quality improvement projects sponsored by the St. Lucie River Issues Team. Other Issues Team projects in this planning unit that are funded and underway include

- the Tenmile Creek Restoration (a Central and Southern Florida [C&SF] Ecosystem Restoration Critical Project that includes construction of a temporary/seasonal storm-water basin to provide treatment and flow equalization of water in Tenmile Creek);
- NSLR Canal Retrofits and NSLWCD Bank Restoration projects, under the Issues Team umbrella, addressing soil erosion and sediment transported by canals;
- the Platt's Creek restoration project that also provides treatment of water entering the North Fork in St. Lucie County; and
- several urban storm-water retrofit projects benefiting the North Fork and SLE. (FDEP, 2003, Basin Status Report)

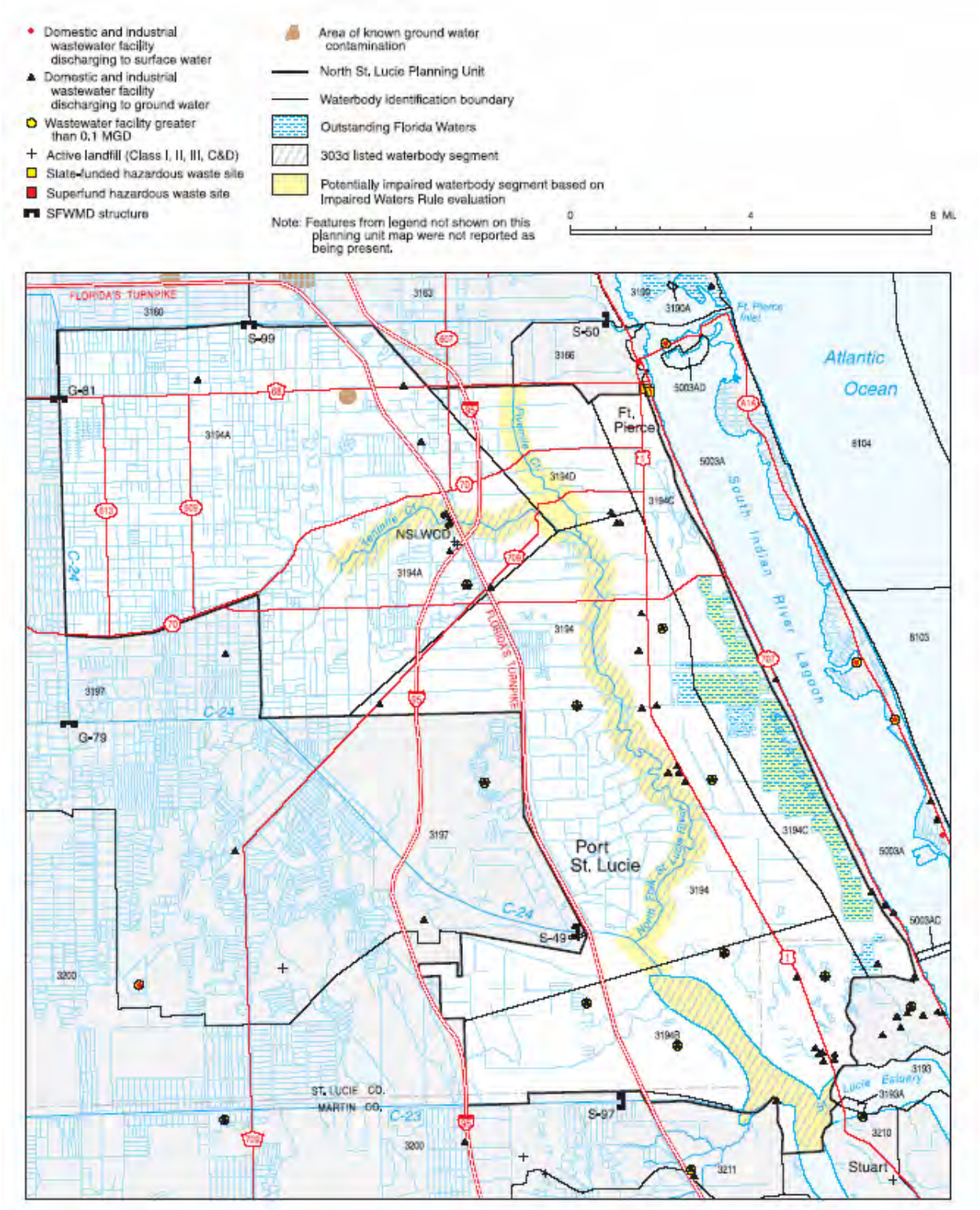

Figure 3: North St. Lucie Planning Unit

Table 1: Land Cover Distribution for WBID 3197.

Land Use Category	Area (square miles)	Percentage of Land Area
Urban and Built-up	18.24	10.70
Agriculture	103.76	60.90
Rangeland	1.28	0.75
Upland Forests	14.51	8.52
Water	2.38	1.40
Wetlands	28.45	16.70
Barren Land	0.51	0.30
Transportation, Communications, and Utilities	1.24	0.73
Totals	**170.36**	**100.00**

4. WATER QUALITY STANDARD AND TARGET IDENTIFICATION

Florida's surface waters are protected for five designated use classifications, as follows:

Class I	Potable water supplies
Class II	Shellfish propagation or harvesting
Class III	Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife
Class IV	Agricultural water supplies
Class V	Navigation, utility, and industrial use (there are no state waters currently in this class)

Waterbodies are classified as Class III freshwaters, with a designated use of recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The water quality criteria for protection of Class III waters are established by the State of Florida in the Florida Administrative Code (F.A.C.), Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 F.A.C. [Surface Waters: Minimum Criteria, General Criteria] that apply to all waters unless alternative criteria are specified in F.A.C. Section 62-302.530. In addition, unless otherwise stated, all criteria express the maximum not to be exceeded at any time. While the State of Florida does not have numeric criteria for nutrients, a narrative criterion exists as described below. The specific criteria are:

4.1 Nutrients

The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter [Section 62.302 F.A.C.]. In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora and fauna [Section 62.302.530 F.A.C.]

For the St Lucie Basin, the nutrient targets will be based on how the nutrients (TN and TP)

impact algae as expressed as Chlorophyll a.

The overall increase in frequency of algal blooms in coastal waters throughout the nation has been attributed to non- point source nutrient pollution. Some algae blooms are toxic and can have adverse health effects on humans. They are frequently implicated as causes of fish kills. Recently, algae blooms have become more frequent in the St. Lucie Estuary and have become a source of public anxiety and media attention. The Southeast District FDEP Ambient Monitoring program conducts monthly sampling of the St. Lucie estuary at four strategic locations to detect and evaluate algae blooms as they occur. The amount of algae in the water is determined by measuring its chlorophyll content, with concentrations of chlorophyll greater than 15 parts per billion (ppb) considered indicative of the onset of a bloom. (FDEP 1999).

The Chlorophyll a goal is a St Lucie River and Estuary wide average Chlorophyll a value of 15 ug/l as measured by the ongoing monthly sampling program. The target is established as a maximum monthly value Chlorophyll a of 15 ug/l as predicted by the St Lucie Chlorophyll a and Nutrient Spreadsheet model. See Appendix B for more modeling details.

4.2 Dissolved Oxygen

Dissolved Oxygen (DO) shall not be less than 5 mg/L for freshwater (C-24) and 4 mg/l for marine waters (St Lucie and North St Lucie). Normal daily and seasonal fluctuations above these levels shall be maintained.

4.3 Biochemical Oxygen Demand (Freshwater)

Biochemical Oxygen Demand (BOD) shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each class and, in no case, shall it be great enough to produce nuisance conditions.

4.4 Natural Conditions

In addition to the standards for nutrients, DO and BOD described above, Florida's standards include provisions that address waterbodies which do not meet the standards due to "natural background" conditions.

"'Natural Background' shall mean the condition of waters in the absence of man-induced alterations based on the best scientific information available to the Department. The establishment of natural background for an altered waterbody may be based upon a similar unaltered waterbody or on historical pre-alteration data." [Section 62-302.200(15) FAC].

Florida standards also state at 62-302.300(15) FAC that "Pollution which causes or contributes to new violations of water quality standards or to continuation of existing violations is harmful to the waters of this State and shall not be allowed. Waters having water quality below the criteria established for them shall be protected and enhanced. However, the Department shall not strive

to abate natural conditions."

5. WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

To determine the status of surface water quality in Florida, three categories of data – chemistry data, biological data, and fish consumption advisories – were evaluated to determine potential impairments. The level of impairment is defined in the Identification of Impaired Surface Waters Rule (IWR), Section 62-303 of the Florida Administrative Code (F.A.C.). The IWR defines FDEP's threshold for identifying water quality limited WBIDs to be included on the state's 303 (d) list. In addition, all waters on the 1998 303 (d) list that were not delisted remain on the current 303 (d) list and require TMDLs.

FDEP maintains ambient monitoring stations throughout the basin. All data collected at monitoring stations within the impaired WBID are used in the analysis. These data are shown in Appendix A.

6. SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of pollutants in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either point or non-point sources.

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities discharging treated sanitary wastewater or stormwater (i.e., Phase I or II MS4 discharges) are considered primary point sources.

Non-point sources are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation on land surfaces and wash off as a result of storm events. Typical non-point sources of nutrients include:

- Wildlife
- Agricultural animals
- Onsite Sewer Treatment and Disposal Systems (septic tanks)
- Urban development (outside of Phase I or II MS4 discharges)

A geographic information system (GIS) tool, was used to display, analyze, and compile available information to characterize potential pollutant sources in the impaired WBID. This information includes land use, point source dischargers, soil types and characteristics, population data

(human and livestock), and stream characteristics.

6.1. Point Sources

According to the FDEP database, there are 36 permitted wastewater treatment facilities in the North St. Lucie planning unit (26 domestic wastewater, 9 industrial wastewater, 1 other). None of
these are permitted to discharge directly to surface water. The largest facility, the Martin County Utilities North (NPDES FLL043192) domestic wastewater plant with land application, has a design capacity of 1.2 mgd and has minimal impact on St Lucie estuary's water quality. There is 1 permitted solid waste landfill in the planning unit, the St. Lucie County Landfill, and 1 permitted construction and demolition (C&D) debris landfill. There are no state-funded or NPL hazardous waste sites, although there is 1 delineated ground water contamination area (for EDB). Also in this planning unit, there are 4 dry cleaning facilities and more than 100 reported discharges from petroleum storage facilities. Figure 3 shows permitted wastewater treatment facilities, landfills, and delineated areas in the North St. Lucie River planning unit.

Municipal Separate Storm Sewer Systems (MS4s) may also discharge pollutants to water-bodies in response to storm events. Large, medium, and small MS4s serving populations greater than 50,000 people, or with an overall population density of 1,000 people per square mile, are required to obtain a NPDES storm water permit. There are three MS4 permits in Martin County; Martin County (FLR04E013), City of Stuart (FLR04E031), and Sewall's Point (FLR04E044). There are also three MS4 permits in St. Lucie County; Fort Pierce (FLR04E065), Port St. Lucie (FLR04E001) and St. Lucie County (FLR04E029).

6.2. Non-point Sources

Runoff from urban and agricultural areas impacts water quality in the North Fork and its tributaries. Urban (48 percent residential and 6 percent commercial) and forest (16 percent of WBID) are the predominant land uses in the WBID. Medium and high density residential development makes up the largest percentage of urban land in the WBID Agricultural animals are the source loadings to streams, that impact water quality. This source includes agriculture runoff from pastureland and cattle in streams. Wildlife deposit nutrients in their feces onto land surfaces where it can be transported during storm events to nearby streams.

6.3. Onsite Sewerage Treatment and Disposal Systems (Septic Tanks)

Onsite sewage treatment and disposal systems (OSTDs) including septic tanks are commonly used where providing central sewer is not cost effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTD is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDs can be a source of nutrient (nitrogen and phosphorus), pathogens, and other pollutants to both ground

water and surface water. The State of Florida Department of Health (www.doh.state.fl.us/environment/ostds/statistics/ostdsstatistics.htm) publishes septic tanks data on a county basis. Table 2 summarizes the cumulative number of septic systems installed since the 1970 census. The data does not reflect septic tanks removed from service.

Table 2. County Estimates of Septic Tank Installations (FDEP, 2004)

County	Number Septic Tanks (1970-2002)
St. Lucie	43,022
Martin	27,284

6.4. Urban Development

Pollutant loading from urban areas is attributable to multiple sources including storm-water runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals.

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of non-point source pollution by requiring new development and redevelopment to treat storm-water before it is discharged. The Stormwater Rule, as outlined in Chapter 403 Florida Statutes (F.S.), was established as a technology-based program that relies upon the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C. Florida's stormwater program is unique in having a performance standard for older storm-water systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older storm-water management systems shall be reduced as needed to restore or maintain the beneficial uses of water" (Section 62-4-.432 (5) (c), F.A.C.).

Nonstructural and structural BMPs are an integral part of the State's storm-water programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the generation of NPS pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimizing impervious surfaces. Technology-based structural BMPs are used to mitigate the increased storm-water peak discharge rate, volume, and pollutant loadings that accompany urbanization.

7. ANALYTICAL APPROACH

Florida DEP (FDEP) is in the process of developing a complex water quality model for the St Lucie Estuary and the related watersheds. See Figure 4. The complex model is partially

completed and covers the North St. Lucie, South St Lucie, C-44, C-23 and C24 Watersheds as well as the discharge from Lake Okeechobee via the C-44 Canal. This TMDL used the initial watershed nutrient loadings calculated by the FDEP modeling project. Chlorophyll a and nutrient (TN and TP) relationships were independently developed (Appendix B). When the FDEP modeling is completed this TMDL should be reevaluated and updated.

7.1. Watershed Nutrient Loadings

Watershed TN and TP daily loads were derived for years 1995 to 2005 for the five major watersheds and from the outflow from Lake Okeechobee via C-44 canal (S308). Table 3 shows the average annual loads for each of these sources.

Table 3: St Lucie Watershed and Lake O TN and TP Loadings

Watershed	Average Annual Flow (cfs)	Average Annual TN Load (#/day)	Average Annual TP Load (#/day)	Average Annual TN Concentration (mg/l)	Average Annual TP Concentration (mg/l)
South Fork Watershed	94	1024	216	2.01	0.42
North Fork Watershed	216	2162	442	1.86	0.38
C24 Watershed	246	2200	527	1.66	0.40
C23 Watershed	199	1231	378	1.15	0.35
C44 Watershed	231	1784	226	1.43	0.18
Lake O via C44 Canal	660	6003	450	1.69	0.13
Total	1646	14403	2239	1.62	0.25

7.2. Chlorophyll a and Nutrient Relationships

Based on the combined North St Lucie and St Lucie data, a Chlorophyll a to TN and TP relationship was developed and a Chlorophyll a and nutrient predictive spread sheet model was developed using this relationship along with the daily predicted watershed and Lake Okeechobee/Canal C-44 flows and concentrations. Appendix B shows the spreadsheet models calibration results for Chlorophyll a, TN and TP. Based on the model results nutrient reductions will be determined that are needed to meet the Chlorophyll a target.

The relationship is for TN/TP ratios less than 7,

Chlorophyll a (ug/l) = 20 * TN (mg/l)

and for TN/TP ratios equal or greater than 7,

Chlorophyll a (ug/l) = 60 * TP (mg/l).

7.3. Dissolved Oxygen

For the St Lucie Estuary WBID 3194, the DO criteria should be met if the Chlorophyll a and nutrient targets are met. This should result in the elimination of the algal blooms, which are the major cause of the low DO in the estuary. When FDEP completes their complex water quality model, direct predictions of DO will be able to be made and further evaluation of meeting the DO criteria can be completed.

For C-24 Watershed WBID 3197, the low DO values are more a function of BOD and the approach for calculating DO TMDLs depends on the number of water quality samples and the availability of BOD data. For BOD, very little data are available and the existing loads are calculated using the Nonpoint Source Spreadsheet Model. The TMDL is expressed as a percent reduction to meet a pollutant concentration target based on natural conditions. The assumption made is that BOD has the major controllable impact on dissolved oxygen. To return dissolved oxygen to a "naturally" expected condition, not impacted by pollutants, the BOD loadings will also need to be returned to natural loading conditions and nutrient levels reduce to meet the St Lucie nutrient target. However, dissolved oxygen is also impacted (lowered) by the instream modifications such as dredging and channelization. These processes slow down the water velocity, reduced reaeration, and increase solids settling thereby increasing sediment oxygen demand (SOD) which may result in a low DO condition. Therefore C-24 Canal WBIB 3197 dissolved oxygen may not achieve the designated water quality standards. Further analyses and monitoring will have to be completed to develop an appropriate site specific dissolved oxygen criterion.

Using the landuse distribution the existing and natural Biochemical Oxygen Demand (BOD) loads were calculated based on an average rainfall of 50 inches per year. The natural values were calculated by assigning the non-water portion of the drainage area half to forest and half to wetlands loading values, see Table 4.

Table 4 WBID 3197 Estimated Existing and Natural or Targeted BOD Loads

WBID	Total Annual BOD Load (lbs/year)
3197	234,190
3197 Natural	127,190

8. DEVELOPMENT OF TOTAL MAXIMUM DAILY LOADS

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody,

identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$TMDL = \Sigma WLAs + \Sigma LAs + MOS$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measures.

8.1. Critical Conditions

The critical condition for the estuary is all year long and is driven by the nonpoint source loads and the loads from Lake Okeechobee. The non-point source loading occurs when an extended dry period is followed by a rainfall runoff event. During the dry weather period, pollutants build up on the land surface, and are washed off by rainfall.. These are also regulated waterbodies with controllable gates that regulate the water. Water quality data have been collected during all time periods. Critical conditions are accounted for in the analyses by using the daily loads calculated from the1995 to 2005 period of record of measured flows (when available) and all water quality data available for the WBID.

8.2. Margin of Safety

TMDLs shall include a margin of safety that takes into account any lack of knowledge about the pollutant loading and in-stream water quality. In this case the measured water quality was used directly to determine the reduction to meet the water quality standard. There are two methods for incorporating a MOS in the analysis: 1) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or 2) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In these WBID's TMDL, an implicit MOS was used by targeting reductions based on daily loads from ten years of record.

8.3. Determination of TMDL, LA and WLA

The TMDL values represent the maximum daily load the stream can assimilate and maintain water quality standards.

Concentrations of chlorophyll greater than 15 parts per billion (ppb) are considered indicative of the onset of a bloom. (FDEP 1999). The Chlorophyll a target is a St Lucie River and Estuary wide average Chlorophyll a value of 15 ug/l as measured by the ongoing monthly sampling program. The target is established as a maximum monthly value for Chlorophyll a. The monthly average value was selected as the most representative of the overall status of the estuary.

The existing conditions spreadsheet model maximum monthly Chlorophyll a value for the St Lucie Estuary is predicted to be 26 ug/l. To reduce this maximum monthly value to the Chlorophyll a target of 15 ug/l, a **TN of 1.2 mg/l and TP of 0.1 mg/l were assigned** from all five watershed sources (nonpoint and point sources including MS4 discharges) and a **TN of 1.2 mg/l and TP of 0.04 mg/l** for Lake Okeechobee discharge to C-44 Canal. The TP value is based on the Lake Okeechobee TMDL. Table 5 gives the nutrient TMDL and Table 6 illustrates the resultant watershed and C-44 canal loadings that are needed to meet the 15 ug/l Chlorophyll a St Lucie Estuary target.

Table 5: St Lucie Estuary Nutrient TMDL

Stream Name / WBID	**Parameter**	**TMDL**
North St Lucie and St Lucie Estuary (3194B and 3194)	TN	3,868,000 #/year or 10,590 #/day
North St Lucie and St Lucie Estuary (3194B and 3194)	TP	245,000 #/year or 670 #/day

Table 6. Summary of Nutrient TMDL Components

Watershed	Average Annual Values Flow (cfs)	TN (#/day)	TP (#/day)	TN (mg/l)	TP (mg/l)	TN % Reduction	TP % Reduction
South Fork	54	610	51	1.20	0.10	40%	76%
North Fork	123	1395	116	1.20	0.10	35%	74%
C-44	132	8055	125	1.20	0.10	16%	45%
C-23	113	1231	107	1.15	0.10	0%	72%
C-24	140	1588	132	1.20	0.10	28%	75%
Lake O	376	4271	138	1.20	0.04	29%	69%
Total	938	17151	670	3.39	0.13		

The TMDL values represent the maximum annual daily load the stream can assimilate and maintain water quality standards. The TMDL components for the DO impaired water-bodies in WBID 3197, requires additional reduction in the BOD loads. Table 7 provides TN, TP and the

BOD percent reduction needed to achieve the Chlorophyll a and DO targets.

Table 7. Summary of TMDL Components for the Impaired WBIDs

Stream Name / WBID	Parameter	WLA for MS4	LA	TMDL
St Lucie (3194)	TN	26.5 % Reduction	26.5 % Reduction	26.5 % Reduction
St Lucie (3194)	TP	70 % Reduction	70 % Reduction	70 % Reduction
North St Lucie (3194B)	TN	26.5 % Reduction	26.5 % Reduction	26.5 % Reduction
North St Lucie (3194B)	TP	70 % Reduction	70 % Reduction	70 % Reduction
C-24 Canal (3197)	TN	28 % Reduction	28 % Reduction	28 % Reduction
C-24 Canal (3197)	TP	75 % Reduction	75 % Reduction	75 % Reduction
C-24 Canal (3197)	BOD	46% reduction	46% reduction	46% reduction

* Percent reductions are an averaged reduction for the TN and TP loads from all contributing watersheds and canals.

8.4. Waste Load Allocations

The waste load allocation for municipally separated storm sewer systems contributing pollutants to the impaired waterbodies is a 26.5 percent reduction for TN and a 70 percent reduction for TP from existing nutrient loads for all watersheds. There are six MS4 permits, these are Martin County (FLR04E013), City of Stuart (FLR04E031), Sewall's Point (FLR04E044), Fort Pierce (FLR04E065), Port St. Lucie (FLR04E001) and St. Lucie County (FLR04E029). The land application facilities have a no discharge permit.

8.5. Load Allocations

There are two modes of transport for non-point source loading into the stream. First, pollutant loading from failing septic systems and animals in the stream are considered direct sources of pollutants to the stream, since they are independent of precipitation. The second mode involves pollutants loadings resulting from accumulation on land surfaces transported to streams during storm events. Data from this WBID shows violations during wet weather and dry weather, so both direct and indirect sources should be targeted by the reductions.

8.6. Seasonal Variation

Seasonal variation was incorporated in the spreadsheet models by using the entire period of record of flow recorded at the gages. Seasonality was also addressed by using all water quality data associated with the impaired WBIDs, which was collected during multiple seasons.

8.7. Recommendations

Determining the source of BOD and nutrients in waterbodies is the initial step to implementing this TMDL. FDEP employs the Basin Management Action Plan (B-MAP) as the mechanism for developing strategies to accomplish the necessary load reductions. Components of a B-MAP are:

- Allocations among stakeholders
- Listing of specific activities to achieve reductions
- Project initiation and completion timeliness
- Identification of funding opportunities
- Agreements
- Local ordinances
- Local water quality standards and permits
- Follow-up monitoring

As this TMDL is implemented, the Agency strongly encourages the development of site-specific dissolved oxygen and nutrient criteria for these WBIDs

9. REFERENCES

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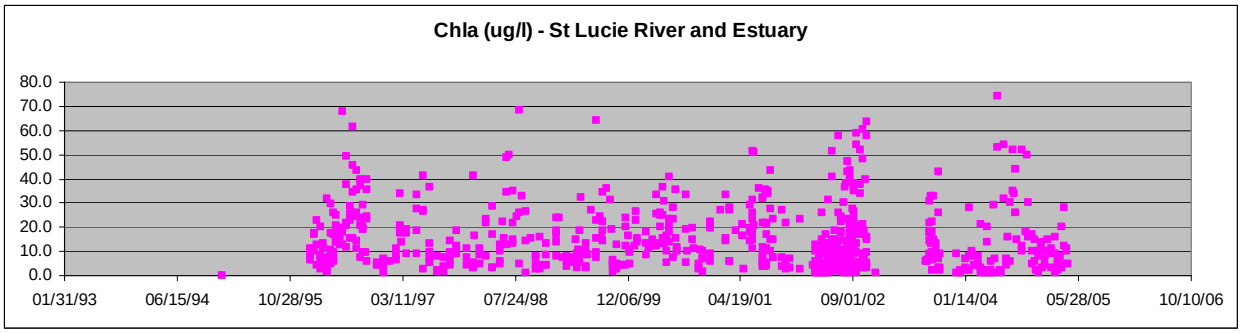
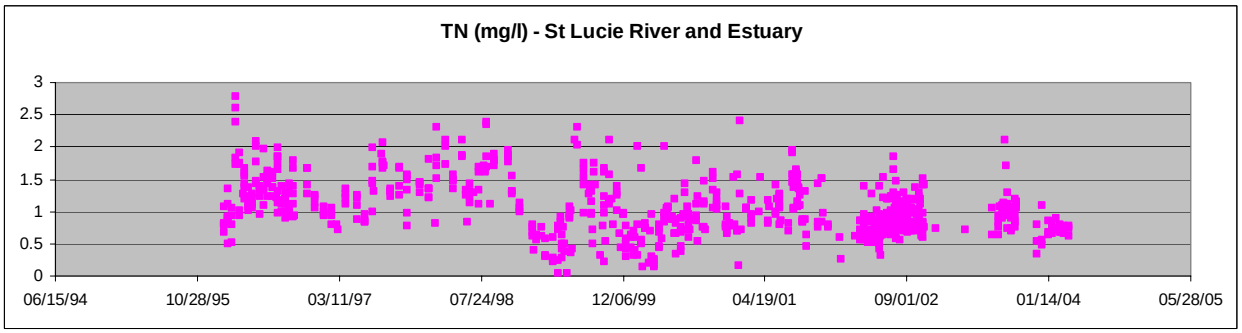
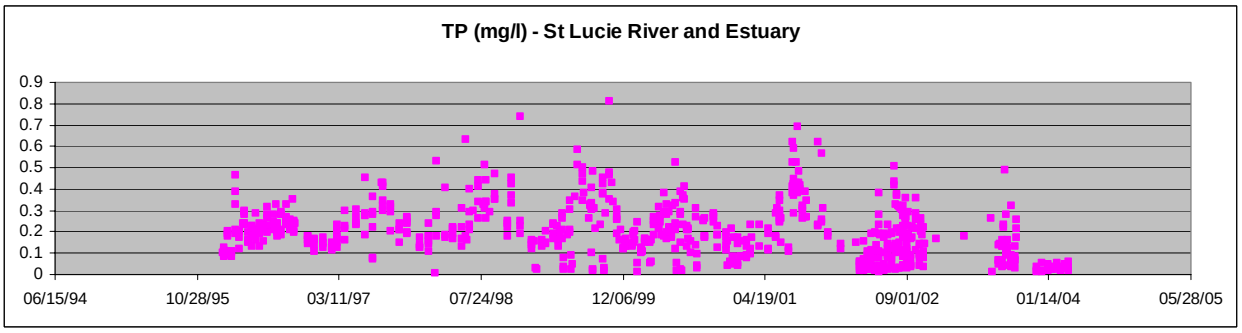
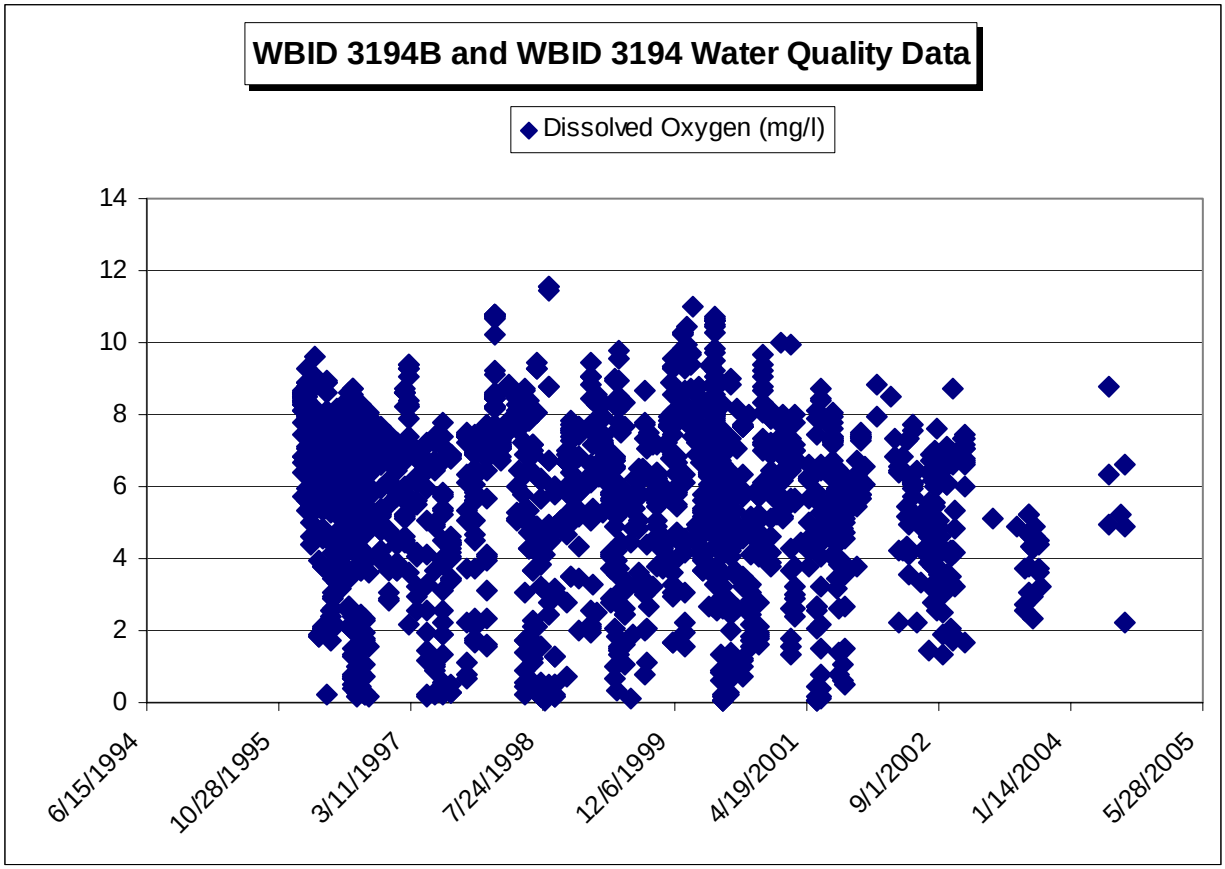
USEPA. 2001. BASINS PLOAD Version 3.0 Users Manual. U.S. Environmental Protection Agency, Office of Water, Washington, DC. 2001.

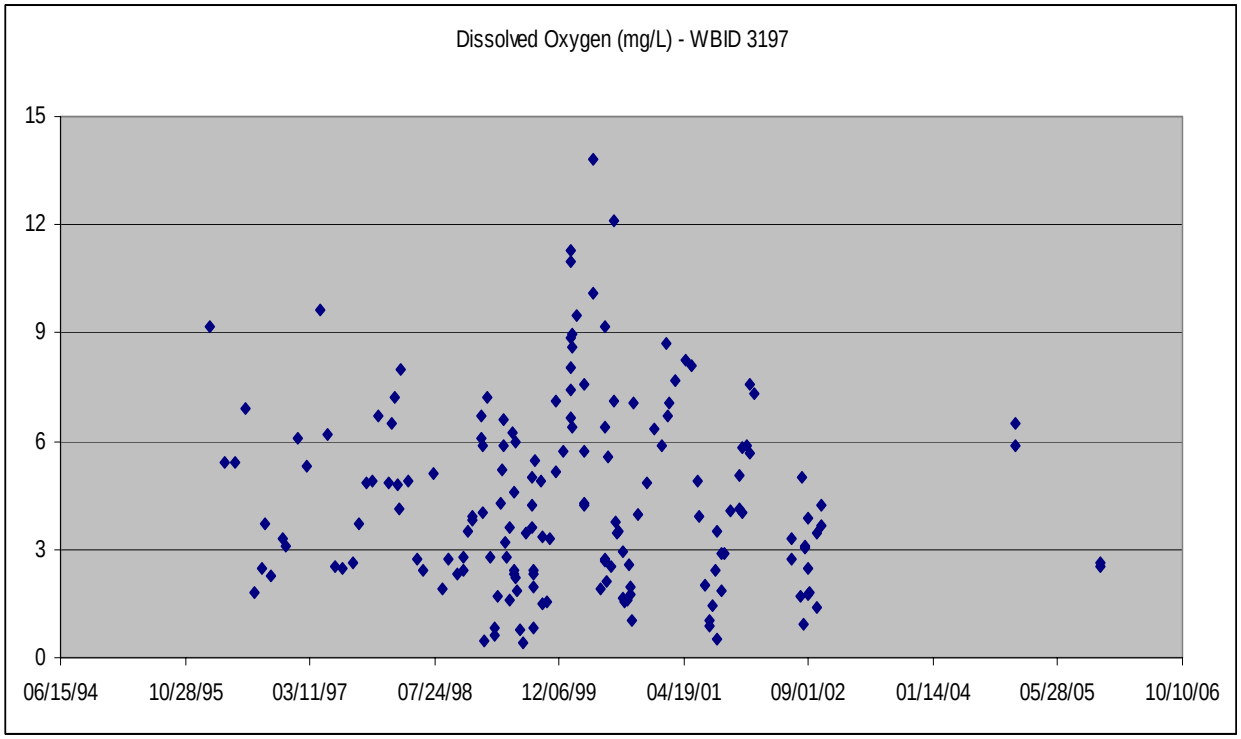
APPENDIX A: WATER QUALITY DATA








WBID 3194B and WBID 3194 Water Quality Data
Dissolved Oxygen (mg/l)
14
12
10
8
6
4
2
0
6/15/1994
10/28/1995
3/11/1997
7/24/1998
12/6/1999
4/19/2001
9/1/2002
1/14/2004
5/28/2005


Dissolved Oxygen (mg/L) - WBID 3197
15
12
9
6
3
0
06/15/94
10/28/95
03/11/97
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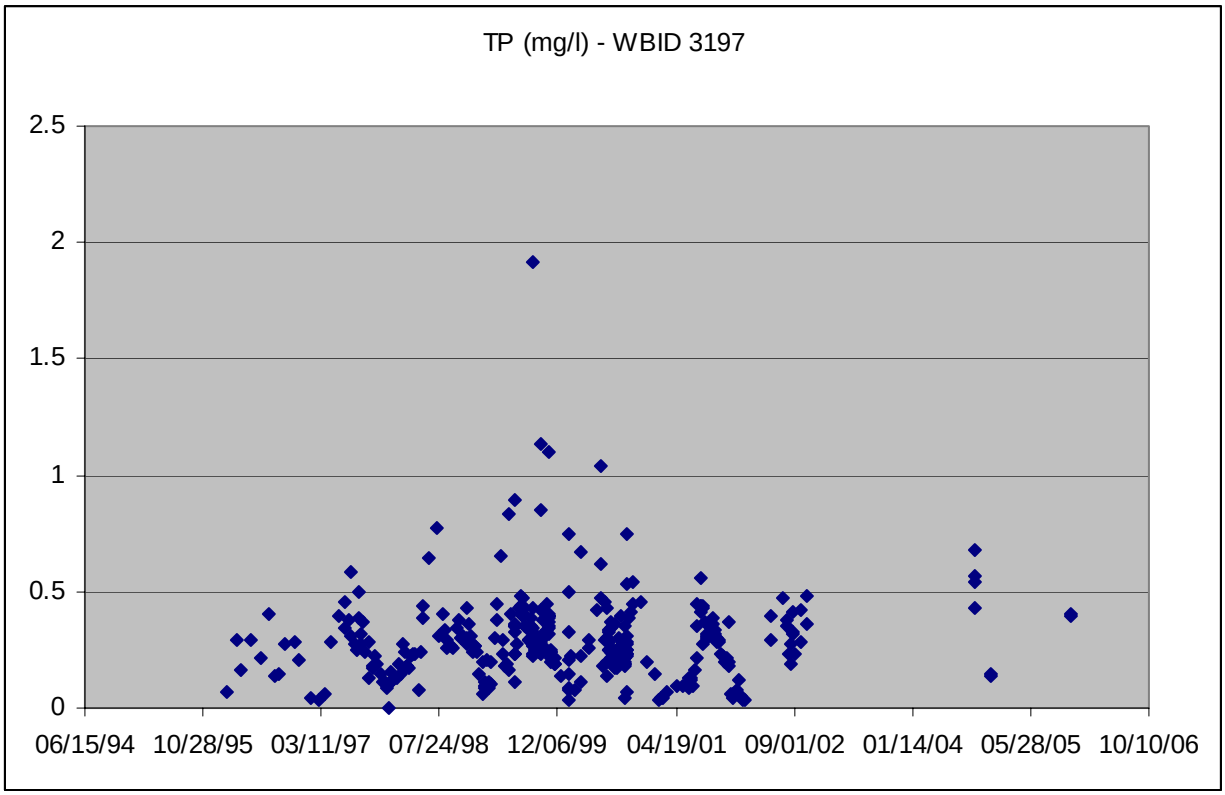
04/19/01
09/01/02
01/14/04
05/28/05
10/10/06


TP (mg/l) - WBID 3197
2.5
2
1.5
1
0.5
0
06/15/94
10/28/95
03/11/97
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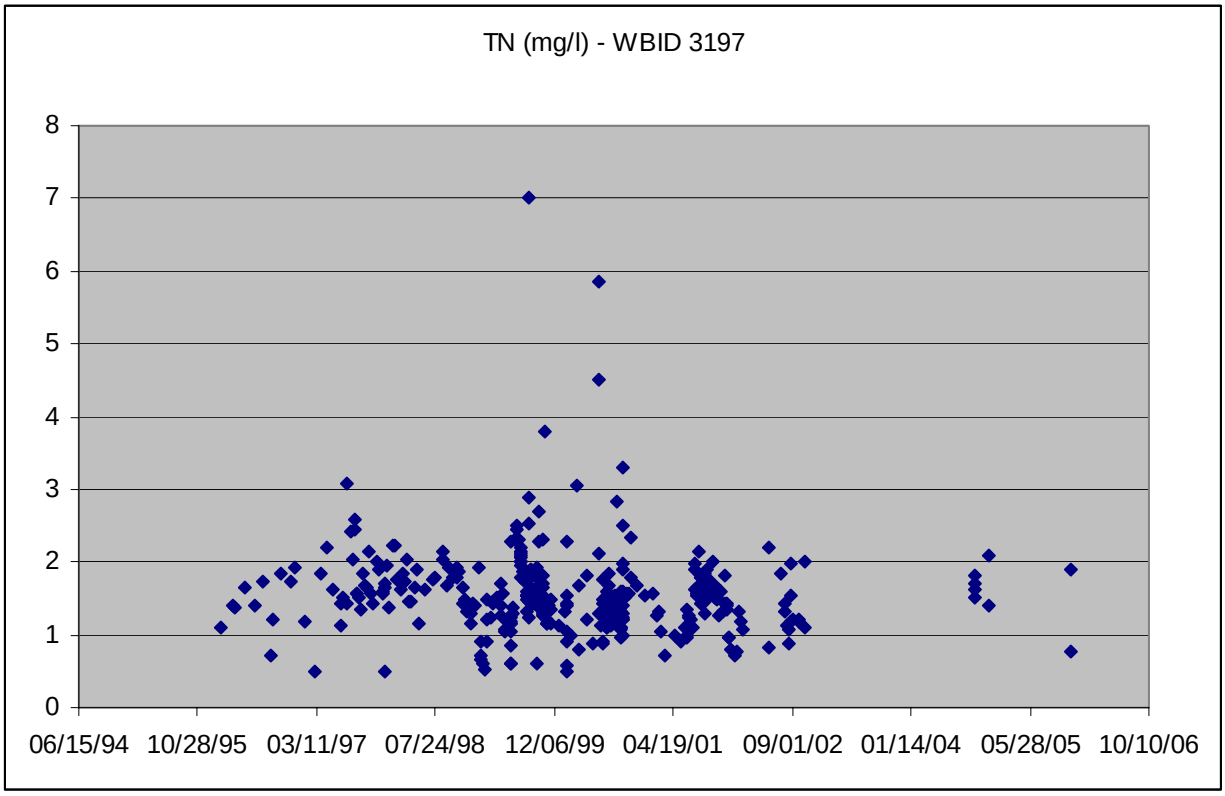
09/01/02
01/14/04
05/28/05
10/10/06


TN (mg/l) - WBID 3197
8
7
6
5
4
3
2
1
0
06/15/94
10/28/95
03/11/97
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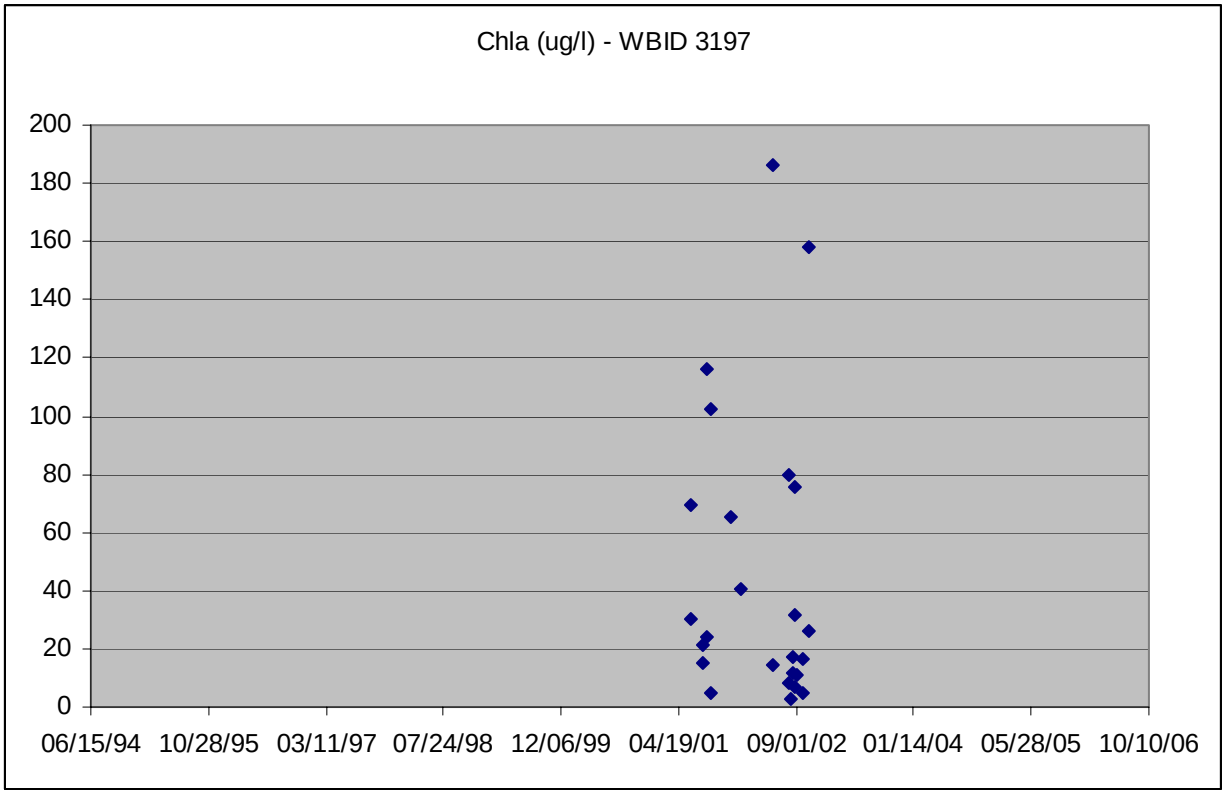
09/01/02
01/14/04
05/28/05
10/10/06

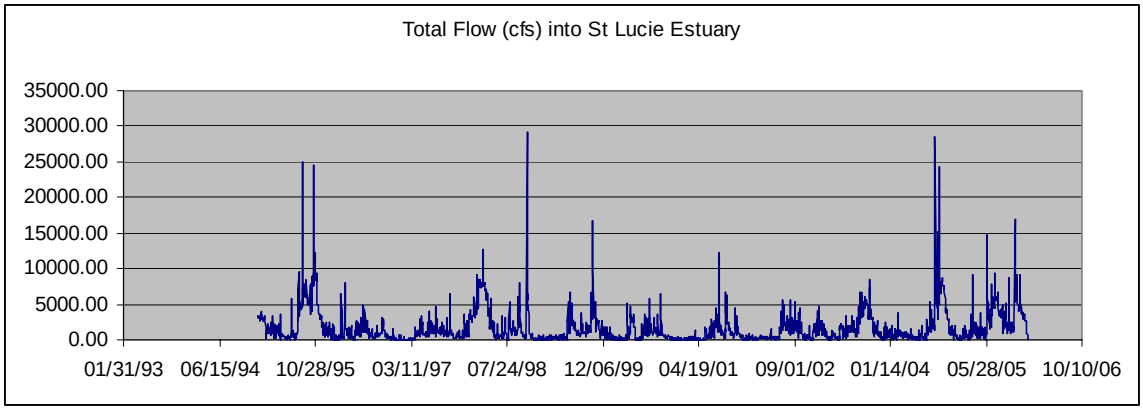

Chla (ug/l) - WBID 3197
200
180
160
140
120
100
80
60
40
20
0
06/15/94
10/28/95
03/11/97
07/24/98
12/06/99
04/19/01
09/01/02
01/14/04
05/28/05
10/10/06

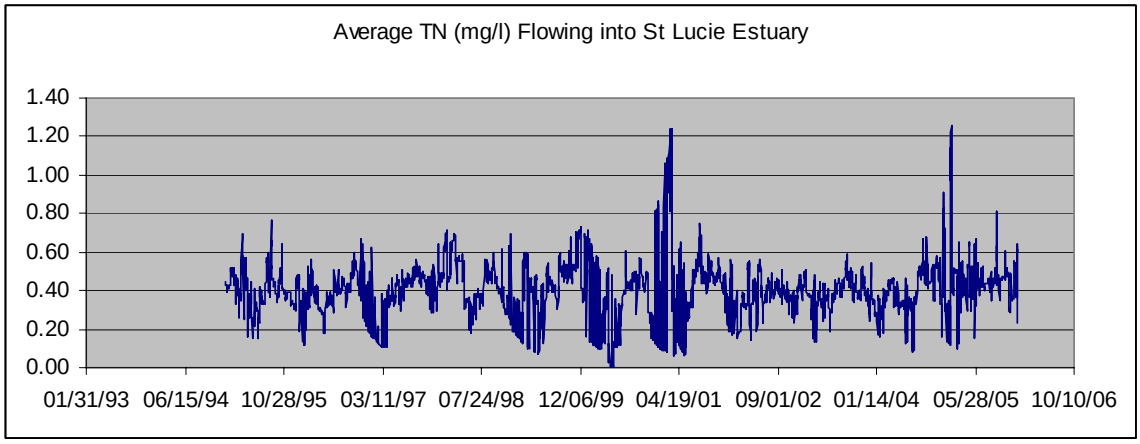
APPENDIX B: CHLOROPHYLL A NUTRIENT SPREADSHEET MODEL FOR ST LUCIE RIVER BASIN

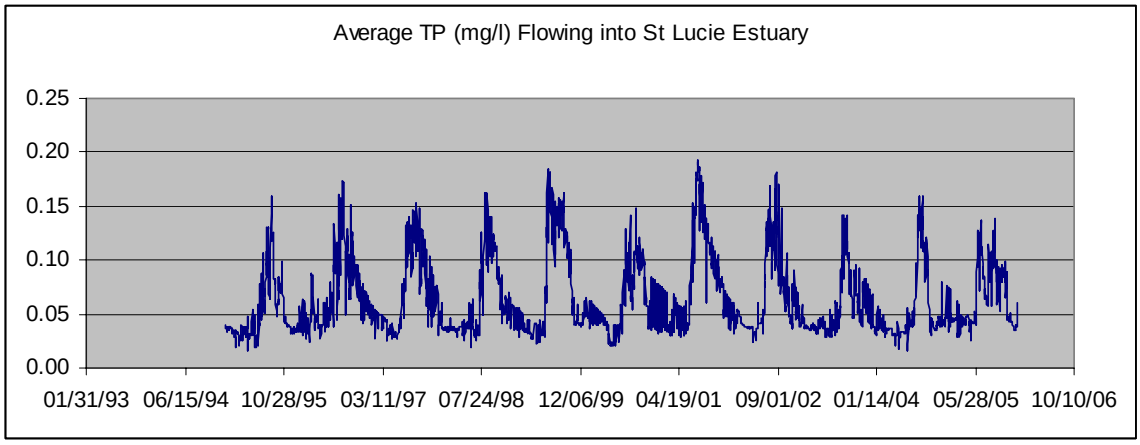
St Lucie River and Estuary TMDL Development
Chla and Nutrients Spreadsheet Model

1. Impairment
    a. St Lucie River 3194B (red square) on verified list for DO and Chla and nutrients
    b. St Lucie Estuary 3194 (below red square) on planning list for DO and Chla and nutrients
    c. EPA to propose TMDL for both WBIDs
2. TN and TP Loadings to the St Lucie River and Estuary
    a. Watershed Description

    Error! Objects cannot be created from editing field codes.
    b. 5 Main Watersheds where daily flows and loads (preliminary) were calculated from FDEP watershed model
    c. Lake O Loads calculated from measured flows and monthly TN and TP data from Lake O S308. Transported to St Lucie Estuary via C44 Canal
    d. 1995 to 2004 Time period







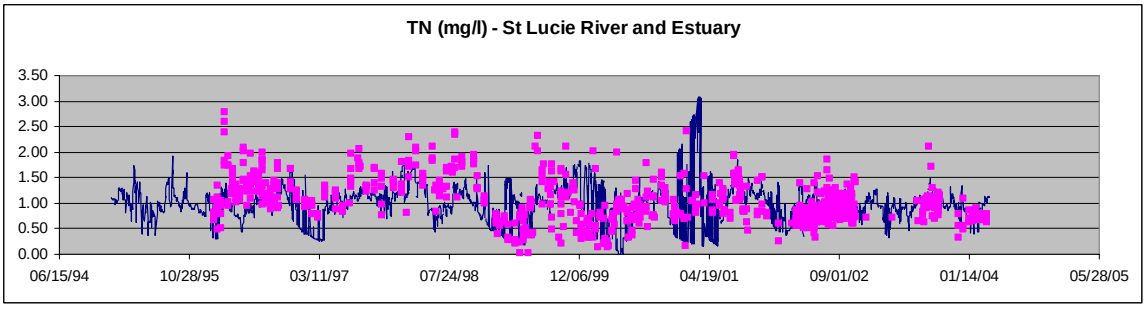
e. Annual Average Loads

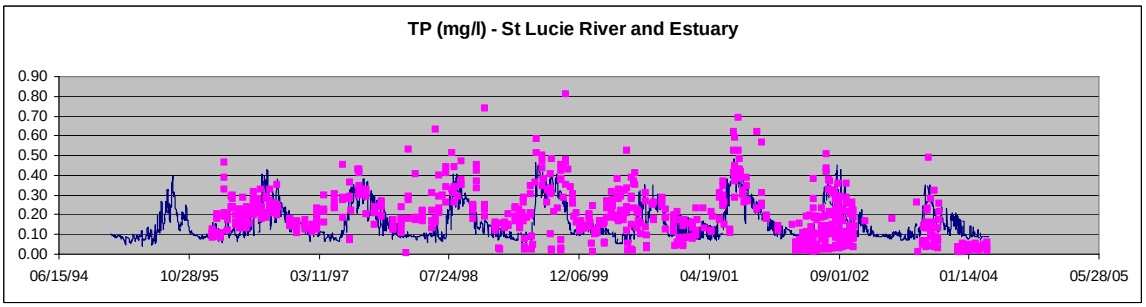
Watershed	Average Annual Flow (cfs)	Average Annual TN Load (#/day)	Average Annual TP Load (#/day)	Average Annual TN Conc (mg/l)	Average Annual TP Conc (mg/l)
South Fork Watershed	94	1024	216	2.01	0.42
North Fork Watershed	216	2162	442	1.86	0.38
C24 Watershed	246	3751	820	2.83	0.62
C23 Watershed	199	1231	378	1.15	0.35
C44 Watershed	231	1784	226	1.43	0.18
Lake O via C44 Canal	660	6003	450	1.69	0.13
Total	1646	15954	2531	1.80	0.29

Watershed	% Flow	% TN Load	% TP Load
South Fork Watershed	6	6	9
North Fork Watershed	13	14	17
C24 Watershed	15	24	32
C23 Watershed	12	8	15
C44 Watershed	14	11	9
Lake O via C44 Canal	40	38	18
Total	100	100	100

3. EPA's Initial St Lucie River and Estuary Chla Spreadsheet Model
    a. Available monthly Chla, TN and TP data from IWR24
        i. Data throughout the river and estuary
        ii. Extremely high Chla values in October 2002 not used as they were not caused by excessive TN or TP – outliers that the equation can not handle
    b. Daily flows, TN and TP concentrations from Watershed Model
        i. Ocean dilution and Instream removal ratio of 0.7 applied to TN and 0.9 applied to TP based on river and estuary data
        ii. "Calibration" graphs

Percentile	Predicted	Measured	Predicted	Measured
	TN (mg/l)		TP (mg/l)	
99	1.51	1.82	0.44	0.42
90	1.36	1.62	0.38	0.35
75	1.18	1.28	0.26	0.26
50	1.02	0.96	0.16	0.17
25	0.84	0.75	0.12	0.09
10	0.59	0.58	0.11	0.03
1	0.34	0.45	0.10	0.02

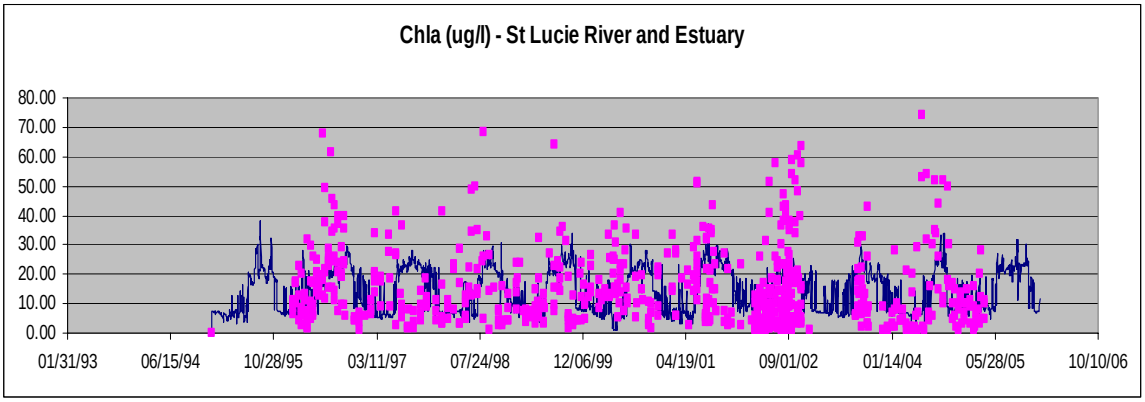




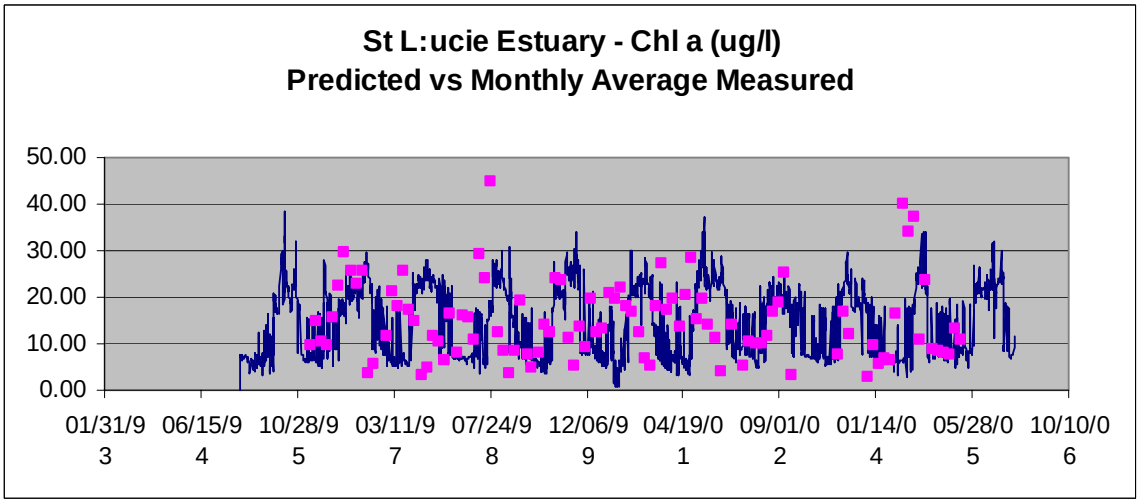
c. TN and TP to Chla relationship developed based on available data
   i. River and estuary treated as a completely mixed bathtub
   ii. For TN/TP ratios < 7; Chla = 20 * TN
   iii. For TN/TP > 7; Chla = 60 * TP
   iv. Minimum Chla of 1 ug/l

d. Predicted vs Measured Results

Percentile	Predicted	Measured
	Chla (ug/l)	
99	25.7	29.1
90	23.9	25.6
75	21.0	19.5
50	14.2	13.1
25	7.2	8.5
10	6.0	5.4
1	5.4	3.8



The Chla spreadsheet model predicts Chla concentrations as an estuary wide average and the estuary Chla is collected monthly, therefore it is more appropriate to use the model as a predictor of area-wide average Chla levels and compare to the monthly average measured Chla data. Predicted Chla average = 16.5 ug/l; Measured monthly average Chla = 14.8 ug/l



4. Chla Target
    a. River and Estuary-wide Maximum Monthly Chla of 15 ug/l, level needed to prevent algal blooms.

For the St Lucie Basin, the nutrient targets will be based on how the nutrients (TN and TP) impact algae as expressed as Chla.

The overall increase in frequency of algal blooms in coastal waters throughout the nation has been attributed to non- point source nutrient pollution. Some algae blooms are toxic and can have adverse health effects on humans. They are frequently implicated as causes of fish kills. Recently, algae blooms have become more frequent in the St. Lucie Estuary and have become a source of public anxiety and media attention. The Southeast District FDEP Ambient Monitoring

program conducts monthly sampling of the St. Lucie estuary at four strategic locations to detect and evaluate algae blooms as they occur. The amount of algae in the water is determined by measuring its chlorophyll content, with concentrations of chlorophyll greater than 15 parts per billion (ppb) considered indicative of the onset of a bloom. (FDEP 1999).

The Chla goal is a St Lucie River and Estuary wide average Chla value of 15 ug/l as measured by the ongoing monthly sampling program. The target is established as a maximum monthly value Chla of 15 ug/l as predicted by the St Lucie Chla Nutrient Spreadsheet model.

5. Reduction Scenarios
    a. Constant TN and TP concentrations (selected alternative)

The existing conditions spreadsheet model maximum monthly Chlorophyll a value for the St Lucie Estuary is predicted to be 26 ug/l. To reduce this maximum monthly value to the Chlorophyll a target of 15 ug/l, a **TN of 1.2 mg/l and TP of 0.1 mg/l were assigned** from all five watershed sources (nonpoint and point sources including MS4 discharges) and a **TN of 1.2 mg/l and TP of 0.04 mg/l** for Lake Okeechobee discharge to C-44 Canal. The TP value is based on the Lake Okeechobee TMDL. Following tables gives the nutrient TMDL and illustrates the resultant watershed and C-44 canal loadings that are needed to meet the 15 ug/l Chlorophyll a St Lucie Estuary target.

Stream Name / WBID	**Parameter**	**TMDL**
North St Lucie and St Lucie Estuary (3194B and 3194)	TN	3,868,000 #/year or 10,590 #/day
North St Lucie and St Lucie Estuary (3194B and 3194)	TP	245,000 #/year Or 670 #/day

Watershed	Average Annual Values					TN % Reduction	TP % Reduction
	Flow (cfs)	TN (#/day)	TP (#/day)	TN (mg/l)	TP (mg/l)		
South Fork	54	610	51	1.20	0.10	40%	76%
North Fork	123	1395	116	1.20	0.10	35%	74%
C-44	132	8055	125	1.20	0.10	16%	45%
C-23	113	1231	107	1.15	0.10	0%	72%
C-24	140	1588	132	1.20	0.10	28%	75%

Lake O	376	4271	138	1.20	0.04	29%	69%
Total	938	17151	670	3.39	0.13		

b. Equal Percent Reductions

	Percent Reduction	Median Simulated Chla	Chla Monthly Avg Maximum	Estuary TN (mg/l)	Estuary TP (mg/l)	Watershed TN (mg/l)	Watershed TP (mg/l)
Existing	0	15.7	26.2	1.02	0.12	1.45	0.17
	20	12.6	20.9	0.81	0.10	1.16	0.14
	35	10.2	17.0	0.66	0.08	0.94	0.11
	40	9.4	15.7	0.61	0.07	0.87	0.10
TMDL #s	43	9.0	14.9	0.58	0.07	0.83	0.10
	50	7.9	13.1	0.51	0.06	0.73	0.09
Background	60	6.3	10.5	0.41	0.05	0.58	0.07

Annual Loads and Concentrations after 43% Reduction

Watershed	Average Annual Flow (cfs)	Average Annual TN Load (#/day)	Average Annual TP Load (#/day)	Average Annual TN Conc (mg/l)	Average Annual TP Conc (mg/l)
South Fork Watershed	94	584	123	1.15	0.24
North Fork Watershed	216	1232	252	1.06	0.22
C24 Watershed	246	2138	467	1.62	0.35
C23 Watershed	199	701	216	0.65	0.20
C44 Watershed	231	1017	129	0.82	0.10
Lake O via C44 Cannal	660	3422	256	0.96	0.07
Total	1646	9094	1443	1.03	0.16